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ABSTRACT

The SOCRATES Computer Assisted Test Retrieval System is a bank of test questions and answers for 11 subject matter areas. The system has been available since 1974 to faculty and students of the California State University and College System. Both batch-mode and interactive versions are available. Telephone requests for test forms or reproduction masters can be made one day and received by courier the following day. Users with data-links to the central processor may have tests printed locally on a high speed computer. Computerized test retrieval and test scoring should be an important resource to busy teachers, but faculty have been slow to accept computer assisted test construction. (CH)

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SOCRATES[1] TEST RETRIEVAL AT THE CALIFORNIA STATE UNIVERSITY AND COLLEGES

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SOCRATES Computer-Assisted Test Retrieval is a service available to faculty and students of the nineteen campus sytem of the California State University and Colleges. SOCRATES provides users with multiple version machine scorable exercises over our state-wide computer network from banks in eleven different subject matter areas. The banks range in size from a few hundred items (Tests and Measurements) to more than fifteen thousand items (American History). Two versions of SOCRATES are available: (1) a batch-mode version[2] that allows users to obtain tests on high-speed printers and (2) an interactive version[3] which may be accessed from any terminal on our time sharing network. There are a number of retrieval options. A user on any campus may request a test by telephone, have it printed either on standard forms or on continuous form reproduction masters and receive the test via courier. Tests requested by telephone before 8:00 P.M. typically are delivered by courier the following day. Users on campuses that customarily establish data-links with the CDC3300 central processor in Los Angeles may elect to have their tests printed at their local campus high-speed printer.

Teachers have long maintained files of questions they feel are suitable for student evaluation. Whether in shoe boxes as individual items, or as copies of old tests, these collections have provided an important instructional resource for teachers in high schools, community colleges, and other institutions where large classes, many contact hours, and marginal student assistant help is the rule. In this sense, "item banks" are not new. Moreover, the assembly of tests from item pools has been a method used increasingly by national testing organizations. The Educational Testing Service has been producing achievement tests in American History and mathematics routinely by this method since 1969.[4] However, the availability of item banks through computer networks has just recently begun to emerge as a novel and powerful tool of the individual classroom teacher. More than one hundred computer accessible item banks have been built at schools and colleges in the United States and Canada. Although their use seems to be increasing, still only a tiny minority of faculty are regular users; the great majority make either marginal use of them or no use at all. This situation may exist because of old habits, because of a lack of awareness about the existence of the banks or because many faculty are intimidated by the computer and believe that anything connected with it requires an operating knowledge of sophisticated gadgetry. There are some who, if not openly hostile to any kind of retrieval system, go out of their way to denigrate its attributes. One critic summed it up: "You are just automating what we all do." those of us who have been active in the promotion of Computer Assisted Test Construction see the act of "automating what we all do" as that of influencing a fundamental change in educational management. Moreover, the nature of the interaction between computer and instructor is such that the use of item banks may very likely prove to be one of the few applications of computers to education that is economical as well as pedagogically effective. Once an item retrieval system has been put into operation it is but a small step to implement an automatic scoring system which keeps records on the performance of the student population being served and monitors the characteristics of usage on each of the items. The teacher is then presented a tool for instantaneous monitoring of student achievement without the burdensome record-keeping procedure that causes so many teachers to avoid individualized instructional methods for large numbers of students. As a small part of the whole area of computer information retrieval and manipulation, CATC combines the threat and promise of establishing standards of achievement within an institution or a group of institutions and it demands the attention and criticism of teachers anxious to move in new directions.

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[1]Student Oriented Classroom Analysis and Test Evaluation System.
[2]Batch-mode SOCRATES written by Mr. Mark Hays, Division of Information Systems, California State University and Colleges.
[3]Interactive SOCRATES written by Mr. Dave Osterberg, California State University, Chico.
[4]Epstein, Marion G., Educational Technology, XIII, 3 (1973).

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The banks were assembled in a format compatible with the Classroom Teacher Support System, a retrieval system developed jointly by IBM and the Los Angeles Unified School District.[1] This system was and still is in use at our San Diego campus, but it is not compatible with the other campus computers. A formal institutional commitment to the development of our item banks began two years ago when a small project was funded to collect and classify questions in the natural sciences. Three banks (chemistry, physics and biology), each containing more than two thousand items, were generated during the project period. The following year, funds were allocated for the development of the SOCRATES retrieval system that would be compatible with all campus computers (including time-sharing). This year a major commitment was made to develop two banks to be used for comprehensive examinations, one in general chemistry and one in accounting. The philosophy behind our administrative support originates in the desire to elevate the student's responsibility in the learning process. The availability of large numbers of items in one subject matter area will allow a student to generate self-tests for a judgment on competency. It will allow teachers to encourage more students to work at their own pace, without the usual accompanying deluge of paperwork resulting from having to evaluate manually numerous students at various stages of progress. The generation of items is completely under teacher control. No knowledge of programming or computer use is required to take maximum advantage of the system. SOCRATES retrieves items by subject category, difficulty, behavior level (requiring knowledge or application of knowledge) and keyword. Questions which require the use of additional material (enhanced items) and questions which always occur together (macro items) are allowed. A test may contain up to one hundred fifty items; each test may be edited (items added or removed) up to ninety-nine times. The printing of tests on continuous form ditto masters is a standard feature and a user may request up to ten scrambled versions of each test. The instructor's time required to prepare a test is significantly redirected. Rather than being involved in the mechanics of producing and grading the test, his time is spent in selecting appropriate items using the request and edit feature of SOCRATES and in evaluating student performance.

The subject matter content classification system is the key to the organization of each bank. There is always a problem of this classification system reflecting personal prejudices of its author. Although this seems to be a somewhat greater problem in fields other than the natural sciences and mathematics, all authors of classification systems have been encouraged to seek opinions on its organization from their colleagues and to avoid any specific teaching approaches, such as programmed instruction, self-paced learning or an emphasis on behavioral objectives, in order to gain the greater user acceptance.

The Chemistry Bank Project: A Case Study

Collections of items in the discipline of freshman general chemistry were obtained from the Educational Testing Service and the Monmouth, Oregon City Schools. Some additional items were obtained from interested faculty members at several campuses. These were coded for category and other selection parameters, keypunched and loaded, resulting in an initial bank of nearly four thousand individual questions. The following manpower was required to build the bank: ½ man-year classifying, proof-reading and editing; ½ man-year in the coordination of the efforts of the keypunch operators, the data processing service and those faculty doing the classifying; ½ man-year of keypunch time. Since that time we have received additional items from bank coordinators at Eastern Michigan University, the University of Pittsburgh and Michigan State University. Approximately two-thirds of these have been incorporated into our bank, increasing the size to more than ten thousand items. The bank is now being used for the same evaluative procedures as have been carried out manually for generations: quizzes, homework assignments, diagnostic tests, challenge examinations, term examinations and comprehensive examinations. Microfiche copies and hard copies of the contents of the bank are made available to students and faculty alike. The implementation of bank use has allowed the exchange of testing methods and educational philosophies between the participating schools. Two examples are worth mentioning. A chemistry department at one of our campuses regularly administers a diagnostic test to incoming students to aid in placing them in the appropriate chemistry course. The test was placed in the chemistry bank so that administration of it became routine. Colleagues on two other campuses learned of its availability and have now begun to use it. The student populations are quite different, as the three schools are located in urban, suburban and rural areas. A project has been initiated to examine the correlation of the

[1] Lippey, G., Toggenburger, F., Brown, C. D., Association for Educational Data Systems Journal, P. 75, March 1971.

diagnostic test scores at each campus with other measures of student performance, such as SAT scores and high school grade point averages, in order to evaluate the test as a general counselling tool. The second example is more of a general nature. Since the development of SOCRATES, numerous requests have been made for the exchange of chemistry item banks. There is obviously an active and dedicated group of educators who are building their own retrieval and testing systems. Since our costs show that approximately $5-$10 are spent for each item placed in the bank, it is to everyone's advantage to share in the production and development of these items. We have encouraged the exchange of banks (most frequently via magnetic tapes) at every turn.

The use of a standard character set presented some initial difficulties because of the absence of numerous symbols used in chemical notation, most noticeably the lower case letters needed for certain elemental symbols, superscripts for exponents and subscripts for chemical formulas. The conventions that were adopted have proved to be serviceable if momentarily upsetting to one who is accustomed to the more commonly accepted representations. Symbols for elements are underlined if they consist of two letters. Thus the symbol Hf is written HF to distinguish hafnium from HF, hydrogen fluoride. Subscripts are shifted one line down so that calcium phosphate appears as $CA_3(PO_4)_2$, and superscripts one line up; carbon-14 is written ^{14}C. Multiplication is indicated with a single asterisk, A*B (the developers of the mathematics bank at San Diego State University found the notation A X B to be relatively unambiguous). Exponents are also shifted to the line above, $C^{1/2}$ representing the square root of C. Chemical equations include the symbols ---------►, ◄=========►, and ◄---------►, for chemical reaction, chemical equilibrium and resonance, respectively. Greek letters have been spelled out, redefined in the text or their numerical equivalents indicated. The Greek letter π is written either as 3.14 or PI. Electron dot formulas may be printed successfully by a judicious use of periods and colons. Graphical designations must be performed either by actually keypunching the pictures, which is enormously time-consuming or supplied separately in the figure file for enhanced items. The items below illustrate some of these conventions:

1. THE VELOCITY OF A BEAM OF NEUTRONS IN A NUCLEAR REACTOR IS $2.0 * 10^{5}$ CM SEC^{-1}. WHAT IS THE DE BROGLIE WAVELENGTH OF THESE NEUTRONS? (MASS OF NEUTRON, M = 1.00899 AMU, H = $6.6 * 10^{-27}$ ERG SEC (PLANCK'S CONSTANT), LAMBDA = H/MV)

   A. $5.4 * 10^{-57}$ CM B. $2.0 * 10^{-12}$ CM C. $1.7 * 10^{-10}$ CM

   D. $6.6 * 10^{-8}$ CM E. $2.0 * 10^{-8}$ CM

2. THE EQUATION FOR THE PREPARATION OF CALCIUM CHLORIDE IS

   $$\underset{100}{CACO_3} + \underset{73}{2HCL} \text{ -------> } \underset{111}{CACL_2} + \underset{18}{H_2O} + \underset{44}{CO_2}$$

   WHERE THE NUMBERS BELOW THE FORMULAS REPRESENT THE RELATIVE WEIGHT OF EACH COMPOUND. THE NUMBER OF GRAMS OF $CACL_2$ THAT CAN BE FORMED FROM 80 GRAMS OF $CACO_3$ IS ABOUT

   A. 89 B. 100 C. 111 D. 173 E. NONE OF THESE

Faculty acceptance of the bank.

SOCRATES has been available to all sixteen thousand faculty and nearly three hundred thousand students since its initial implementation in June, 1974. The system is capable of delivering tests within minutes for a request placed from a local campus terminal and from several hours to two days for telephone requests (delivery by courier), depending upon the distance of the campus. Copies are neat and, in time, they will be error-free. Surely faculty will view this service as a path leading to further freedom for educational innovation, particularly in the areas of modular education, self-testing and even the traditional lecture-examination approach. Yet faculty have been slow to accept Computer Assisted Test Construction. It is clear that teachers have not yet developed the same partnership with the computer that they have enjoyed with their typewriters (or secretaries). Selecting items from a card file, assembling them and requesting a typed copy, or, more often than not, typing them oneself, is a method which holds a powerful grip on many teachers. An added problem is that teachers perceive themselves to be a very discriminating group when it comes to selecting items. In our effort to be all things to all users, we have tread on the stylistic or subjective toes of some. A partial solution to this problem is to develop large banks in terms of content, mode, style and difficulty; second, it is necessary to update a bank frequently by adding new items, deleting items with a large user rejection rate and editing errors. Since users assume that each test is tailor-made for them, they are piqued when, after one or two test modifications, the result is not precisely and completely to their liking. On the other hand, students are a resourceful and hardy lot. Many of the caveats raised by instructors turn out to be relatively minor to the student when the time comes to read and interpret the questions on the exam. In other words, the test is a useful measure of student performance, depending less on exam content than on the preparation of the class. Some instructors take this into consideration by generating two exams in the same subject area. One, including answers, is given to the student to study prior to the testing period. The second, with completely different questions but the same objectives is actually used to measure student achievement.

We are encouraged by the great enthusiasm expressed by teachers who are exposed to the capabilities of Computer Assisted Test Construction and not at all discouraged by the slow increase in its use, if for no other reason than that it allows us to do what we are already doing, but for more students at various levels of progress, less expensively, more quickly and with fewer errors. It is a fact that innovative products and techniques require years and sometimes decades to gain full acceptance. McLuhan's observation that "in the age of Xerox, every man is a publisher" is even more appropriate for information retrieval from computers. We think that the awakening has occurred, but the giant is still groggy.